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A Summary of Current Program and
Preliminary Report of Progress

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SUGAR RESEARCH

of the

CURRENT SERIAL RECORDS

United States Department of Agriculture
and related work of the
State Agricultural Experiment Stations

This progress report is primarily a research tool for use of scientists and administrators in program coordination, development, and evaluation; and for use of advisory committees in program review and development of recommendations for future research programs.

The summaries of research progress include some tentative results that have not been tested sufficiently to justify general release. Such findings, when adequately confirmed, will be released promptly through established channels. Because of this, the report is not intended for publication and should not be referred to in literature citations. Copies are distributed only to members of Department staff, advisory committee members, and others having a special interest in the development of public agricultural research programs.

This report also includes a list of publications reporting results of U.S.D.A. and cooperative research issued during the past year. Current agricultural research findings are also published in the monthly U.S.D.A. publications, Agricultural Research and The Farm Index.

UNITED STATES DEPARTMENT OF AGRICULTURE
Washington, D. C. 20250

December 1, 1966

RESEARCH ADVISORY COMMITTEES

The following Research Advisory Committees were established pursuant to Title III of the Research and Marketing Act of 1946:

- | | |
|-----------------------------------|-----------------------------------|
| 1. Farm Resources & Facilities | 8. Cotton |
| 2. Utilization | 9. Grain & Forage Crops |
| 3. Human Nutrition & Consumer Use | 10. Horticultural Crops |
| 4. Marketing | 11. Oilseed, Peanut & Sugar Crops |
| 5. Agricultural Economics | 12. Plant Science & Entomology |
| 6. Forestry | 13. Tobacco |
| 7. Animal & Animal Products | |

The source materials used by the advisory committees include organizational unit progress reports and subject matter progress reports. The latter contain information which was first reported in the organizational reports and has been assembled for use by commodity committees. The number prefixes shown below refer to advisory committees listed above.

ORGANIZATIONAL UNIT PROGRESS REPORTS

Agricultural Research Service (ARS)

- 1 - Agricultural Engineering
- 1 - Soil & Water Conservation
- 2 - Utilization -- Eastern
- 2 - Utilization -- Northern
- 2 - Utilization -- Southern
- 2 - Utilization -- Western
- 3 - Human Nutrition
- 3 - Consumer & Food Economics
- 4 - Market Quality
- 4 - Transportation & Facilities
- 7 - Animal Husbandry
- 7 - Animal Disease & Parasite
- 12 - Crops
- 12 - Entomology

Economic Research Service (ERS)

- 1, 5 - Economic Development
- 4, 5 - Marketing Economics
- 5 - Farm Production Economics
- 5 - Economic & Statistical Analysis
- 5 - Foreign Development & Trade
- 5 - Foreign Regional Analysis
- 5 - Natural Resource Economics
- 6 - Forest Service - Research (FS)
- 4, 5 - Farmer Cooperative Service (FCS)
- 4, 5 - Statistical Reporting Service (SRS)

SUBJECT MATTER PROGRESS REPORTS

- 6 - Forestry (other than Forest Service)
- 7 - Animal-Poultry & Products Research other than Husbandry, Disease and Parasite
- 8 - Cotton and Cottonseed
- 9 - Grain and Forage Crops
- 10 - Horticultural Crops
- 11 - Oilseed and Peanut
- 12 - Sugar
- 13 - Tobacco

A copy of any of the reports may be requested from Max Hinds, Executive Secretary, Oilseed, Peanut & Sugar Crops Research Advisory Committee, Research Program Development & Evaluation Staff, U. S. Department of Agriculture, Washington, D. C. 20250

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INTRODUCTION

This report, which is prepared annually, deals with work directly related to the production, processing, distribution, and consumption of sugarcane, sugarbeets, and sweet sorghum. It does not include extensive cross commodity work, much of which is basic in character, which contributes to the solution of not only sugar problems, but also to the problems of other commodities. Progress on cross commodity work is found in the organizational unit reports of the several divisions.

The report covers Farm Research; Nutrition, Consumer and Industrial Use Research; and Economic Research. As shown in the table of contents, there is a breakdown of the research program by problem areas.

For each subject matter area there is a statement of the problem, USDA and cooperative program, information about the program at State Experiment Stations, if available, a summary of progress during the past year on USDA and cooperative programs and a list of publications including State work where this information is available.

Research on sugar crops is supported by (1) Federal funds appropriated to the research agencies of the U. S. Department of Agriculture, (2) Federal and State funds appropriated to State Agricultural Experiment Stations, and (3) private funds allotted, largely by sugar industries, to research carried on in private laboratories or to support of State Station or USDA work.

Research by USDA

Farm Research in the Agricultural Research Service comprises investigation on introduction, breeding, and genetics, variety evaluation, culture, diseases, nematodes, weed control, insects, and crop harvesting and handling operations and equipment. It is carried out in the following divisions: Crops, Entomology, and Agricultural Engineering. The work involves 73.6 professional man-years of scientific effort.

Nutrition, Consumer and Industrial Use Research conducted in the Agricultural Research Service discussed in this report pertains to the chemical and physical properties, new and improved products, new and improved processing technology of sugar crops. The research was conducted by the following divisions: Southern Utilization Research and Development Division, Consumer and Food Economics, and the Human Nutrition Divisions. The work on sugar beets at the Western Utilization Division and work on sugarcane at both the Northern and Southern Utilization Divisions was terminated at the close of the 1965 fiscal year. Publications pertaining to sugar beet research conducted prior to termination of the program at the Western Utilization Research Laboratory are included in this report. The continuing research effort involves 2.6 professional man-years.

Economic Research pertains to the organization and performance of markets with respect to market institutions and market power; prices, margins, and costs; and location and interregional competition. This work is conducted by the Marketing Economics Division of the Economic Research Service. Research in cooperative marketing is conducted by the Farmer Cooperative Service. The sugar research in these services involves 2.6 professional man-years.

Interrelationships Among Department, State and Private Research

A large part of the Department's research is cooperative with State Experiment Stations. Many Department employees are located at State Stations and use laboratory and office space close to or furnished by the station. Cooperative work is jointly planned, frequently with the representatives of the producers or industry participating. The nature of cooperation varies with each study. It is developed so as to fully utilize the personnel and other resources of the cooperators, which frequently includes resources contributed by the interested producers or industry.

Research by industry and other organizations is sponsored primarily by beet and sugarcane companies, processors, sugar refiners, and chemical companies.

Beet sugar companies conduct applied research on breeding and genetics, nutrition, and agronomic practices, including production and processing of sugar beet seed. The Department supplies new varieties and conducts the basic research needed by the beet sugar companies in their research program.

Large companies that grow sugarcane in Florida, Louisiana, Puerto Rico, and Hawaii conduct research on breeding, variety evaluation, cultural practices, fertilization, and the use of chemicals to expedite (1) the accumulation of sugar in sugarcane and (2) harvesting operations. Valuable developments from such research is made available to Federal and State scientists who cooperate by conducting the basic research necessary to such activity.

Chemical companies conduct research for the development of more effective fungicides for the control of diseases which attack sugar crops and for seed dressings. Also some chemical companies are engaged in the formulation of chemicals for use as desiccants, as fungicides, as growth stimulants, and as retardants to hasten maturity of sugarcane. Federal and State groups provide the basic and fundamental phases essential to this area of research.

Basic research done by the Department and States will be utilized by industry and other organizations in their research programs, especially in the further development of improved products and equipment. Industry's cooperation in supporting sugar research at Federal and State Stations has contributed greatly to its success.

I. FARM RESEARCH

SUGAR PLANT BREEDING AND GENETICS, DISEASES, QUALITY
AND VARIETY EVALUATION, CULTURE AND PHYSIOLOGY
Crops Research Division, ARS

Problem. There is need for accelerated research to establish fundamental principles in genetics, pathology, and physiology of sugar crops, which will provide guidance for concomitant improvement in both quality and acreable yield under high levels of soil fertility and mechanized farming. Research should be expanded to include preharvest problems related to postharvest physiological changes and spoilage that occur in storage.

Diseases of sugar crops, especially virus yellows of sugarbeet and ratoon stunting of sugarcane, affect quality and reduce yield. New strains of the curly top virus of sugarbeet and of the mosaic virus of sugarcane are capable of severely damaging varieties that are tolerant to strains formerly prevalent in a region. Soil-inhabiting pathogens attack the root systems of sugarbeet and of sugarcane, inflicting heavy losses, and the microbial flora of the rhizosphere may have a bearing on unthrifty growth of sugar crops and on the failure of sugarcane plantings to endure repeated harvest and regrowth.

Breeding research should be accelerated to utilize our wealth of germ plasm in the development of parental lines, varieties, and hybrids of sugar crops that are excellent in quality, resistant to diseases and insects, and tolerant to low temperatures. Labor requirements for sugar production should be reduced through the development of varieties of sugar crops that are suitable for mechanized farming. Basic genetic research should be strengthened to develop principles of breeding with special emphasis on the mode of inheritance of chemical constituents and on resistance to pathogens and insects.

PROGRAM--USDA AND COOPERATIVE PROGRAMS

The Crops Research Division has a continuing, long-term program of basic and applied research on sugarbeet, sugarcane, and sweet sorghum with 57.6 professional man-years devoted as follows: 22.3 to breeding and genetics, 14.1 to diseases, 11.9 to quality and variety evaluation, and 9.3 to culture and physiology. These man-years are distributed for crops as follows: Sugarbeet - 12.7 to breeding and genetics, 7.5 to diseases, 6.3 to quality and variety evaluation, and 3.0 to culture and physiology; Sugarcane and Sweet Sorghum - 9.2 to breeding and genetics, 6.5 to diseases, 5.0 to quality and variety evaluation, and 4.8 to culture and physiology.

In addition to research at Beltsville, Md., and at Federal Field Stations in Calif., La., Fla., Miss., and Ga., investigations are conducted cooperatively with State Experiment Stations on sugarbeet in Calif., Ariz., Utah, Colo., Mich., Minn., Maine, and N. Y.; and on sugarcane and

sweet sorghum in La., Fla., Miss., Ala., Ga., Tenn., South Carolina, Texas, Ky., and Puerto Rico.

Cooperative sugarbeet work on contributed funds is conducted at Salinas, Calif., Logan, Utah, Fort Collins, Colo., and Beltsville, Md., with the Beet Sugar Development Foundation; at East Lansing, Mich., and Beltsville, Md., with the Farmers & Manufacturers Beet Sugar Association; and at Salinas, Calif., with the Union Sugar Division, Consolidated Foods Corporation, and the California Beet Growers Association. Research on sugarcane and sweet sorghum is carried out in cooperation with the American Sugar Cane League in La. and Fla., with the Cairo Cane Growers' League in Ga., with the Florida Sugarcane League in Fla., with the Hawaiian Sugar Planters' Association in Hawaii, and in Puerto Rico on funds contributed by the Association of Sugar Producers of Puerto Rico.

There are eight extramural projects pertaining to sugarbeet research: Summer and winter cropping of sugarbeet, Arizona Agricultural Experiment Station, Tucson, Ariz.; Breeding sugarbeet for northeastern states, Cornell Agricultural Experiment Station, Ithaca, N. Y.; Physiological effects of virus yellows on sugarbeet, California Agricultural Experiment Station, Davis, Calif.; Chemical constituents influencing quality of sugarbeet, Colorado Agricultural Experiment Station, Fort Collins, Colo.; Raffinose formation and decomposition in sugarbeet, Utah Agricultural Experiment Station, Logan, Utah; Influence of acid soils on nutrition and growth of sugarbeet, Maine Agricultural Experiment Station, Orono, Maine; Quantitative growth of the sugarbeet, Colorado Agricultural Experiment Station, Fort Collins, Colo.; and Effects of cultural practices and variety on keeping quality of sugarbeet, Michigan Agricultural Experiment Station, East Lansing, Mich. Two extramural projects pertain to sugarcane research: Physiological and biochemical studies on yield decline in sugarcane, Experiment Station, Hawaiian Sugar Planters' Association, Honolulu, Hawaii; and Acceleration of yield decline in sugarcane through application of stress, Experiment Station, Hawaiian Sugar Planters' Association, Honolulu, Hawaii.

Under Public Law 480 grants, research is being conducted on tetraploidization of sugarbeet in Spain, on yellow wilt in Chile, on Cercospora leaf spot in Israel, and on interspecific hybrids of Beta in Poland. In India, U.S. and Indian sugarcane clones are being hybridized with Saccharum spontaneum and other species to develop cold-, disease-, and pest-resistant germ plasm suitable to evolve superior commercial varieties for the United States.

PROGRAMS OF STATE EXPERIMENT STATIONS

A total of 44.8 professional man-years is devoted to this area of research.

PROGRESS--USDA AND COOPERATIVE PROGRAMS

A. Breeding and Genetics1. Sugarbeet

a. Monogerm Seed. Monogerm varieties comprised 99.3% of the 1965 crop of sugarbeet seed in the United States. Thus, for the first time, monogerm seed is available for all sugarbeet districts of the United States. The American sugarbeet is now monogerm, which makes feasible complete mechanization of all field operations in sugarbeet production. This outstanding accomplishment has been brought about through cooperative efforts of Federal and State agencies and the beet sugar industry.

b. New Parental Lines and Hybrids. A continuous flow of new, improved parental lines and experimental hybrids of sugarbeet are being made available for evaluation and utilization. Two monogerm hybrids (US H7 and US H8) have been released and seed is available for grower use. Many parental lines have been tetraploidized in Spain under P.L. 480 contract, and they are being used in the production of triploid hybrids. Triploidy has tended to enhance root yield over that of related diploid sugarbeet, but the sucrose percentage has been low and seed germination has been unsatisfactory.

c. Interspecific Hybridizations. Several years of persistent effort in the hybridization of sugarbeet and wild species of Beta has produced numerous interspecific populations that carry desirable genetic factors not found in cultivars of sugarbeet. These populations have been studied genetically and cytologically to overcome the difficult problem of sterility and lack of viability. Segregants have been found in the F₂ and b₂ generations that are either immune or extremely resistant to the cyst nematode (Heterodera schachtii). This is a significant accomplishment because immunity to this pest is not found in the sugarbeet and occurs only in the wild species of Beta used in the hybridizations.

2. Sugarcane

New varieties of sugarcane having high sugar content, resistance to diseases and insects and to cold damage, and adapted for mechanical harvesting are developed through breeding research at Canal Point, Fla., Houma, La., Meridian, Miss., and Cairo, Ga. Most of the parental clones are superior selections from progenies of former crosses; some special crosses were made in 1965 to broaden the genetic base and provide material for studying the inheritance of important varietal characteristics. In the 1965-1966 crossing season, 403 crosses made at Canal Point provided approximately 1,780,957 viable seed to produce more than 350,000 seedlings for field evaluation in Louisiana, Florida, and the sirup-producing areas. Approximately 70% of the seedlings in Louisiana were discarded because of susceptibility to mosaic.

- a. Germ plasm. Research at Canal Point and Houma to develop new germ plasm for the breeding program provided about 30,000 seedlings during 1965 from interspecific and intergeneric crosses for evaluation under field conditions. The crosses involved five genera closely related to sugarcane and two species of Saccharum. New techniques for crossing diverse types of sugarcane were evaluated at Canal Point. Approximately 4,000 seedlings from interspecific crosses made in India under P.L. 480 project A7-CR-1 are being evaluated at Beltsville, Md., and Houma, La., for resistance to mosaic, the ratoon stunting disease, and cold damage.
- b. Selections. Approximately 5,000 sugarcane seedlings were selected in La., Fla., Miss., and Ga. during 1965 for further, more critical evaluation. The selection work was not completed in Louisiana because of severe hurricane damage; however, the unselected clones will be studied further in the stubble crop. Evaluation of promising selections, under a range of experimental conditions, is in cooperation with Agricultural Experiment Stations in La., Fla., Ga., Miss., and Puerto Rico, and the American Sugarcane League, the Cairo Cane Growers' League, the Florida Sugarcane League, and the Association of Sugar Producers of Puerto Rico.
- c. Crossing techniques. Special investigations at Canal Point during 1965 show that maintaining plants in an 11.5-hour dark period, from September 13 to October 29, delayed flowering in seven parental clones. This delayed flowering made it possible to complete crosses considered impossible in the past. Further investigations with photoperiod treatments and the use of deionized water may effectively extend the crossing potential of parental varieties in the World Collection at Canal Point.
- d. Genetic studies. Investigations were initiated at Houma in 1965 to study the inheritance of resistance to red rot infection in sugarcane and inheritance of plant characters associated with yield. Progenies from seven selected crosses will be used for these investigations. Studies were also initiated to determine the inheritance of resistance to borer damage.
- e. Genetic studies of the mosaic virus. Purification of the sugarcane mosaic virus for genetic studies is in progress in Beltsville, Md. Column fractionation, centrifugation, and related techniques used up to date have been inadequate to free the virus of chlorophyll and similar cell components. Further research is in progress to purify the virus for genetic studies.
- f. World Collection. The World Collection of five species of Saccharum, special hybrids, and related grasses comprises approximately 1,500 clones of valuable germ plasm.
- g. Special studies initiated in January 1966 provide valuable information about the sugar content and vegetative characteristics of the

clones. Freezing temperatures at Canal Point on January 31, 1966, provided an opportunity to evaluate some of the varieties in the Collection for cold resistance. Studies were initiated to determine the synonym of clones in the Collection. Further studies are in progress to measure with accuracy the relationship of clones within botanical groups.

3. Sweet Sorghum

Varieties of sweet sorghum, superior in yielding ability, quality of juice for sirup and sugar production, and resistance to diseases are developed by breeding at Beltsville, Md., Meridian, Miss., Cairo, Ga., and Brawley, Calif.

a. Isogenic lines. Further research to evaluate isogenic lines of the sweet sorghum variety, Tracy, were carried out at Meridian, Miss., in 1965. These studies included inoculation of selfed progenies and back crosses of selected lines with spores of Colletotrichum graminicolum to determine resistance to the disease. Significant improvement in quality of sirup from eight of the isogenic lines indicates the potential value of the technique in sweet sorghum research.

b. Hybrid varieties. Further investigations carried out at Meridian, Miss., in 1965 to develop hybrid varieties of sweet sorghum indicated the need for more satisfactory parental varieties for maintaining the male sterility factor. These investigations will be continued in the search for improved parental lines.

c. World Collection. Approximately 400 varieties of the World Collection were subjected to severe inoculation tests at Beltsville, Md., and Meridian, Miss., during 1965 to evaluate them for resistance to red rot (Colletotrichum graminicolum), zonate leaf spot (Gloeocercospora sorghi), and bacterial stripe (Pseudomonas andropogoni). Data about productive capacity, sugar content, date of flowering, and relative adaptability to abnormal seasonal conditions were obtained from the study.

B. Diseases

1. Sugarbeet

a. Curly Top. Studies on curly top transmission under controlled environment have demonstrated that growth and development of the sugarbeet have greater influence on incidence of infection than sex, stage of development, or period of virus acquisition of the leafhopper vector (Circulifer tenellus). As the age of the seedlings at the time of inoculation increases, the incidence of infection decreases. The incidence of infection for cotyledon inoculation was as great as when inoculations were made through the first true leaves. Curly top infection increased with the number of leafhoppers per seedling.

b. Yellows Virus. Further progress has been made in control of virus yellows of sugarbeet through breeding for tolerance. Yellows resistant parental lines have been released for use in the improvement of commercial varieties.

A new strain of the yellows virus has been found with a wide host range including members of the mustard family which do not show yellows symptoms when inoculated with the strains of the virus formerly occurring in California.

c. Root Rots and Black Root. Progress is being made in the control of *Rhizoctonia* root rot and seedling black root through breeding for resistance to the pathogens. A breeder seed developed from three generations of selection for resistance to *Rhizoctonia solani* was outstanding in root yield under exposure to the pathogen and represents a new level of resistance. Black root resistance has been enhanced in new monogerm lines of sugarbeet through exposure to *Aphanomyces cochlioides*. Resistant lines are now available for commercial production of monogerm hybrids.

2. Sugarcane

Mosaic and the ratoon stunting diseases are the two most important diseases of sugarcane in Louisiana and Florida. These two diseases are caused by viruses. Both diseases are apparently related to the decline in yield of sugarcane varieties. Most of the current pathological research relates to these two diseases.

a. Mosaic. Mosaic is now a major disease problem in the Louisiana sugarcane industry. Yields of some of the commercial varieties are reduced 30% or more by a heavy infection of the disease. Control of the disease by roguing is generally not effective; however, in some areas, where the job has been done carefully, the percentage of infection is low. Varietal resistance is the only real control for the disease. Heat treatment of seedcane to control the ratoon stunting disease has increased susceptibility of some varieties to mosaic. Effective industry-wide control with resistant varieties is not apparent at this time. Studies are in progress in Louisiana and Florida to identify varieties of the World Collection that are resistant to known strains of the disease. Varieties that show resistance will be placed immediately in the breeding program. There is an indication that control of weed host plants of insect vectors may reduce the spread of mosaic in commercial fields. Further study is needed to substantiate these early indications. Studies are in progress to purify the virus for serological tests, and to determine factors that influence resistance to mosaic, transmissibility of the virus, and the influence of temperature on infection. Some of the research is designed to identify an improved assay plant for mosaic.

b. Ratoon stunting disease. Data from field experiments in Louisiana show that yields of cane from seedcane free of the ratoon stunting disease (RSD) range from 4 to 27% higher than from infected seedcane. Yields of sugar per acre were not significantly different from healthy and infected seedcane. Control of the ratoon stunting disease by heat treatment provides some help with the problem; however, this is an expensive and partially effective remedy. Inoculations of healthy seedcane at Houma with juice from RSD-infected and healthy cane show that the presence of the virus had no significant influence on germination. When seedcane is dipped in sugarcane juice, there is a reduction in germination and a suppression of growth of the young plants. Since this condition can be removed by heat-treating the juice, it is apparently caused by some factor other than the virus. Studies are in progress to purify the virus for use in serological tests.

c. Pythium. In Florida, data from field experiments indicate that highly pathogenic isolates of the Pythium arrhenomanes organism are prevalent in muck soils of the Lake Okeechobee area. The highly pathogenic pythiaceae loci were not uniformly distributed throughout the upper six-inch soil level. Growth parameters for a range of strains of Pythium indicate significant differences in growth. Quantitative parameters of root growth with Sart variety of sweet sorghum as the host plant provided excellent information about the relative pathogenicity of the strains. Techniques were developed during the year in Florida and Puerto Rico for rapid isolation of Pythium species from the soil and host roots.

d. Leaf scald. In October 1965, leaf scald (Xanthomonas albilineans) was observed in the Humacao area of Puerto Rico on B. 49119. Isolates of the organism were used to effectively inoculate healthy plants of the variety. Host range and pathogenicity studies for the leaf scald organism have been initiated at Gurabo, Puerto Rico.

3. Sweet Sorghum

a. Red rot (Colletotrichum graminicolum). Comparative tests in Mississippi show that inoculation of susceptible plants of sweet sorghum with a spray suspension of spores or with finely crushed trash infected with the fungus were equally effective in infecting the susceptible plants. Infection was slower from trash inoculation but equally effective at the time of harvest. Varieties in the World Collection of sweet sorghum are being tested for susceptibility to red rot at Beltsville, Md., and Meridian, Miss.

b. Zonate leaf spot (Gloeocercospora sorghi). In field experiments at Beltsville, Md., Meridian, Miss., Houma, La., and Cairo, Ga., varieties susceptible to infection by the organism can be detected by inoculation of young plants. The inoculation is done by distributing trash, collected from plants that show infection, in the spindle of the young

plants. When favorable climatic conditions are available, susceptible plants become highly infected with the disease. The procedure used will make it possible to detect resistant lines now available in the World Collection.

c. Sugarcane Mosaic. Two varieties of sweet sorghum, Rio and Sart, have been used extensively in preliminary investigations as assay plants for the sugarcane mosaic virus. Limited tests at Canal Point indicate that Rio may be a very satisfactory assay plant. There is an indication now that strains of the mosaic virus cause different symptom expressions in Rio plants.

C. Quality and Varietal Evaluation

1. Sugarbeet

a. Nutrition and Quality. The availability of nutrients has a profound influence on root yield, and the effect on quality may not be recognized. Three years of research on quality in relation to chemical constituents has shown a significant negative correlation between potassium in the clear juice and sucrose percentage, indicating that a high rate of application of this nutrient may decrease quality. The results have shown that for each ten pounds of nitrogen applied to the crop, approximately three additional pounds of sugar per ton of roots will be diverted to molasses.

b. Regional Variety Tests. Experimental hybrids and commercial varieties have been evaluated in regional tests conducted in the Great Lakes region and the Great Plains region east of the Rocky Mountains. In the Great Plains tests, where both curly top and leaf spot may be factors in sugarbeet production, a new hybrid (FC (502/2 x 504)MS x SP 59B18-0) gave gross sugar yield of 13% above the yield of the standard. The regional tests in the Great Lakes region revealed new experimental hybrids better adapted than the commercial varieties now in use.

2. Sugarcane

Varieties of sugarcane developed in the breeding program at Canal Point, Fla., are evaluated for yield, sugar content, and disease and cold resistance in cooperation with Agricultural Experiment Stations in La., Fla., Miss., Ala., and Puerto Rico, the American Sugar Cane League, the Florida Sugarcane League, the Cairo Cane Growers' League, and the Association of Sugar Producers of Puerto Rico. In 1965 varietal evaluation under more than a dozen soil types and growth conditions indicated the superiority of five varieties in Louisiana, C.P. 61-39, C.P. 61-84, L. 60-25, L. 61-43, and L. 61-67; and five in Florida, C.P. 56-59, C.P. 59-73, C.P. 57-614, C.P. 63-588, and U.S. 59-16-1. Further tests are needed to effectively evaluate most of these promising varieties under a range of growing conditions in both plant cane and stubble crops.

a. New Varieties. Data from field experiments in Florida show that U.S. 59-16-1 is approximately equal to the standard variety, Cl. 41-223 in productive capacity, milling qualities and disease resistance; it is superior to Cl. 41-223 in stubbling qualities following freeze damage. This variety has been recommended for joint release by the Florida Agricultural Experiment Station and the Crops Research Division for commercial culture in Florida. Data from cooperative experiments throughout the sugarcane-growing region of Louisiana show that L. 60-25 is superior to current commercial varieties in yielding capacity. The new variety produces approximately 20% more sugar per acre than the standard C.P. 52-68. L. 60-25 was released by the Louisiana State Experiment Station, the American Sugar Cane League, and the Crops Research Division for commercial culture in Louisiana in May 1966.

b. Cold-Resistant Varieties. In Louisiana, special experiments to evaluate the vegetative injury to sugarcane plants by frost indicates that light transmission and density thickness of the leaves may be an important factor. Further tests are needed to fully evaluate these findings. Freezing temperatures of 23 and 18 degrees F. under field conditions in Louisiana had a differential influence on varieties. The effect on the varieties was measured by deterioration and quality of the juice eight days after the freeze. In Mississippi, a temperature of 20 degrees F. on December 1 had a differential influence on sugarcane varieties. Four varieties, C.P. 63-316, C.P. 63-317, C.P. 63-345, and C.P. 63-509 sustained the least amount of damage. There was no correlation between leaf-and stalk-resistance to freeze damage.

3. Sweet Sorghum

Sweet sorghum varieties developed in breeding programs at Beltsville, Md., and Meridian, Miss., are evaluated in cooperation with Agricultural Experiment Stations in La., Ala., Ga., South Carolina, Ky., Miss., Tenn., and Texas. New varieties are evaluated in the eight States on more than 20 soil types under a wide range of growth conditions for sirup and sugar production; they are also evaluated under irrigated conditions in the Imperial Valley of California.

a. New Varieties. A new variety, Mer. 59-1, developed at Meridian, is promising for sirup production in Miss., Tenn., Ala., and La., based on regional variety tests in 1965. The new variety resists lodging, producing a fair yield of good quality sirup per acre. Seed supply of a new variety is being increased in 1966 with the objective of releasing it for commercial culture. Rio continues to be the most promising variety for the Rio Grande Valley of Texas. Resistance to diseases, favorable yields of stalks per acre, and a high quality of juice are the dominant characteristics of this variety.

D. Culture and Physiology

1. Sugarbeet

a. Photosynthesis and Respiration. The net accumulation of plant material which represents the difference between photosynthesis and destructive respiration is determined in a hermetically-sealed chamber through measurement of carbon dioxide concentration. The work has demonstrated that the diploid sugarbeet has a higher net accumulation rate than the tetraploid at several levels of light intensity. The total photosynthesis is about the same for both ploidy levels, and the difference in net accumulation is due to higher respiration rate in the tetraploid.

2. Sugarcane

a. Growth of Varieties. The growth period in Louisiana extended from March 10 to December 8, 1965, with one interruption in September by Hurricane Betsy. Growth of commercial varieties was approximately normal and somewhat less than C.P. 61-39 and other new unreleased varieties. Daily temperatures in September resulted in development of flower primordia and the tasseling of C.P. 52-68 and N.Co. 310 in some areas of the sugarcane belt.

b. Photosynthesis in sugarcane. In field experiments in Louisiana the rate of photosynthesis was found to increase with increasing light intensity with no evidence of light saturation below 12,000 foot-candles. This high correlation between photosynthesis and light intensity was accompanied by increased leaf porosity. Increased leaf porosity was accompanied by an average increase in stomata width, suggesting light intensity as a critical controlling factor in stomata movement and photosynthetic activity. In a replicated field test of ten varieties, there were significant differences between varieties and the rates of photosynthesis, porosity, light transmission, leaf thickness, density thickness, and stomatal number and length.

c. Fertilization. In Louisiana yields of cane and sugar per acre were not increased when applications of nitrogen exceeded 80 pounds per acre. There was an increase in yield of cane when the rate of nitrogen per acre was increased from 40 to 80 pounds. In a five-year summary of experiments to determine the variety x nitrogen interactions in Louisiana, it was determined that there was no significant interaction. Applications of complete fertilizer mixtures (N, P_2O_5 , K_2O) were not superior to applications of nitrogen alone under Louisiana conditions. In Georgia, sugarcane yields were closely related to applications of potash. Sixty pounds of potash increase yields three tons, 120 pounds - 5.3 tons, and 180 pounds - 6.3 tons per acre. There was no difference in yields from muriate of potash and sulfate of potash. In Mississippi, applications of four tons of lime per acre increased the pH in the top soil from 5.5 to 7.1; however, this application had no influence on yield

of cane.

d. Flowering. In Hawaii, tasseling was delayed from two weeks to two months in 42% of the clones tested in an experiment subjected to night light interruptions from July to September; there was earlier tasseling in one variety. In the same experiment, flowering was prevented in 40%, and not delayed in 16%, of the clones. Light interruption at night appears to be a practical way for delaying tasseling for many varieties.

e. Preservation of tassels. Data from an experiment in Hawaii to evaluate DMSO (Dimethylsulfoxide) indicate that the chemical did not preserve tassels satisfactorily during the pollination period when the treatments were changed every twelve days. Further testing with shorter intervals between solution changes are necessary to evaluate use of this compound for the preservation of tassels.

f. Pollen preservation. Pollen collected from Saccharum robustum or S. robustum hybrid clones, vacuum dried and applied to tassels of a parent variety failed to produce normal seedset under conditions in Hawaii. Germination for treated and checks were approximately the same in this experiment.

g. Tissue Cultures of sugarcane. Stools of sugarcane developed from tissue culture plants produced thin stalks and smaller leaves than regular plants of the same variety under field conditions; however, secondary, tertiary, and later stalks that grew from these stools were normal and gave the same yield of cane produced from regular seedcane. Reduction in size of stalks, leaves, and number of stalks caused by environmental stress is overcome in subsequent populations, grown under normal environmental conditions.

h. Plant excretions and secretions. Data from basic studies in Hawaii indicate that there are at least three growth-inhibiting substances that occur in extracts from dry roots of sugarcane. These inhibitors may influence the growth of the crop directly, or they may have an indirect influence. Further work is being done by specialized techniques to compare the inhibitory substances on growth of several varieties. Plants of sweet sorghum and seedlings of sugarcane proved to be effective for measuring the general effect of inhibitors on plant growth. Further tests are underway to specifically identify these growth substances.

3. Sweet Sorghum

a. Dates of planting and harvesting. Yields of stalks, extraction, Brix, sucrose, and purity of Rio were not significantly influenced by different dates of planting and of harvesting in an experiment at Meridian, Mississippi. When the stalks were harvested four weeks after the ripe stage, there was a slight decline in Brix. Extraction and purity declined, whereas the Brix increased in storage.

b. Harvest data. In an experiment at Brawley, Calif., juice from field samples treated with bichloride of mercury were: (1) frozen immediately and (2) stored at room temperature. When the samples were analyzed several weeks later, there was no significant difference in the quality of the juice. These data indicate the possibility of using bichloride of mercury for preserving sweet sorghum juice for experimental work without freezing.

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WEED AND NEMATODE CONTROL Crops Research Division, ARS

Problem. Weeds cause losses in crops, orchards, grazing lands, forests, water supplies, and irrigation and drainage systems. The losses caused by weeds can be reduced by finding more effective, chemical, biological, mechanical, cultural and combination methods of weed control. Improved weed control methods will facilitate farm mechanization, greatly increase production efficiency, and improve the efficiency of the use of human and land resources in agriculture.

Plant-parasitic nematodes occur in all soils used for growing of crop plants and attack all kinds of plants grown for food, forage, fiber, feed, or ornamental purposes. It has long been known that severity of attack of certain fungi is greatly increased if nematodes are present; and nematodes have been known to be the vectors of several plant viruses. There is a need for improvements in the methods of controlling nematodes by crop rotations, cultural practices, chemicals, and biological methods on sugar crops.

USDA AND COOPERATIVE PROGRAM

Much of the weed control research in the Department is cooperative with State Experiment Stations, other Federal agencies, industry and certain private groups. The work is cross commodity in nature. The weed control program involves a total of 82.0 professional man-years. Of this total, 3.0 are specifically directed to weed control in sugar crops.

The Federal scientific effort devoted to basic and applied nematode research is 29.3 professional man-years, of which 2.2 is devoted to applied research in sugar crops at Salinas, California; Baton Rouge, Louisiana; and Logan, Utah.

PROGRESS - USDA AND COOPERATIVE PROGRAMS

A. Weed Investigations

1. Sugarbeets. The effectiveness of combinations of herbicides for early postemergence control of broadleaf weeds in sugarbeets last year were confirmed in studies again this year at eight locations in Iowa, Minnesota, and North Dakota. Greenhouse studies in Minnesota indicated that certain broadleaved weeds may be selectively removed from sugarbeets with a combination of diuron plus a surfactant applied broadcast postemergence to both beets and weeds. The sugarbeets tolerated rates up to 0.2 lb/A while young lambsquarters and pigweed seedlings were killed by 0.05 lb/A.

In Colorado, the most effective combination of preplanting and postemergence mixtures of herbicides was TD 282 at 2.5 lb/A plus pyrazon at 3.7 lb/A applied preplanting and followed by pyrazon at 3 lb/A plus dalapon at 3 lb/A postemergence. Kochia was not satisfactorily controlled by any treatment. Broadleaved weeds were more susceptible to certain herbicides applied as broadcast applications than directed sprays while weed grasses were more susceptible to herbicides applied as directed sprays. Beet injury was two to three times greater from broadcast applications of herbicides compared with the same herbicide applied as directed sprays. The development of directed applications of herbicides in beets is a difficult problem because of the growth form of the crop plant.

In Washington, preplanting, soil incorporated applications of pebulate at 4 lb/A continued to provide good control of barnyardgrass in sugarbeets. Control of lambsquarters was somewhat less effective. The beets recovered from fairly severe early season injury. A related compound, R-2063, at 3 lb/A provided weed control equal to that from pebulate and caused much less crop injury. Preplanting, soil incorporated pyrazon, while giving good control of annual weeds in sugarbeets, reduced the sugarbeet stand more than 75% in Washington. These results will need extensive investigation, particularly in light of reports received in early 1966 of injury to sugarbeets in California from pyrazon applied in a manner similar to the Washington experiments.

2. Sugarcane

Residues. Sugarcane treated with MSMA before May 28, had a trace amount of arsenic, but cane treated thereafter had a significantly higher arsenic content.

Winter Weeds. Research in Louisiana showed that heavy infestations of winter weeds such as burclover and chickweed can severely retard the growth of sugarcane in the spring. Control of these weeds with preemergence herbicides resulted in more stalks of cane per acre at harvest.

General Herbicide Performance. A directed spray of MSMA was effective in controlling raoul grass in sugarcane. Two broadcast postemergence applications of MSMA effectively controlled Johnsongrass from rhizomes, but the second application caused severe crop injury. These results emphasize that research to find safe selective herbicides for use in crops must be a carefully and extensively conducted program. H 732 was much less toxic to sugarcane than either of the two analogs, H 629 or H 767. A combination fall and spring preemergence application of H 732 at 2 lb/A per application controlled Johnsongrass seedlings and a broad spectrum of broadleaf and grass weeds for approximately 2 months. Two substituted pyridines, picloram and pyriclor, at 1 to 3 lb/A effectively controlled Johnsongrass seedlings, and prevented seedling preemergence. Picloram gave longer control than pyriclor, but pyriclor was less toxic to sugarcane.

Johnsongrass on Ditchbanks. Sodium chlorate, or low rates of residual herbicides such as bromacil and fenac or multiple applications of MSMA can be used to effectively control Johnsongrass on ditchbanks without eliminating all desirable vegetation. This research finding may prove very important in the control of weeds along ditchbanks in sugarcane fields.

B. Nematodes in Sugar Crops

1. Sugarcane. Plant-parasitic nematodes were controlled in Louisiana sugarcane by row applications of dichloropropenes, (Telone), dibromochloropropane (Nemagon), and a mixture of dichloropropenes and methylisothiocyanate (Vorlex). The best nematocide treatment increased plant-cane by 3.2 tons per acre without reducing sucrose content, and first-year stubble-cane by 6.6 tons per acre with an increase in sucrose content.

2. Sugarbeets. The intensive cultivation of sugarbeets in Utah is increasing sugarbeet cyst nematodes as well as Fusarium oxysporum and Rhizoctonia solani. The fungi frequently occur in fields fumigated for nematode control. Field experiments in 1955 using specific nematocides and wide-range soil fumigants that controlled nematodes, weeds, and pathogenic soil fungi, established that nematodes are a major cause of sugarbeet losses in Utah. Sugarbeet yields from unfumigated plots were 10.0 tons per acre, 18.8 tons per acre for a nematocide, and 20.9 tons per acre for a wide range soil fumigant, indicating the principal damage was caused by nematodes. These findings were supported by greenhouse experiments in which Fusarium oxysporum caused an additive disease effect, of low magnitude, to the primary effect of the sugarbeet cyst nematode. Greenhouse studies at Salinas, California, showed that the effects of sugarbeet cyst nematodes and beet-yellow virus act separately, and additively, in reducing plant growth. There was some indication that sugarbeet-yellows in the Salinas test, and Fusarium in the Logan tests, interfered with or inhibited nematode development.

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SUGARCANE AND SUGARBEET INSECTS
Entomology Research Division, ARS

Problem. Control of insects on sugarcane and sugarbeets is essential because of destructive plant diseases spread by insects and damage caused. The use of insecticides for insect control requires special care to avoid contamination of the harvested product with undesirable residues. Safe effective methods of control are especially needed for the sugarcane borer, the sugarbeet root maggot, and the beet webworm. Sugarcane mosaic has become more important in recent years, and information on insect vectors of this disease is needed. Beet yellows and associated western yellows virus diseases of sugarbeets continue to threaten the sugarbeet industry. Emergency chemical control measures for the aphid vectors of the viruses of these diseases are urgently needed. Studies on the ecology and methods of control of the weed reservoirs of the insects that transmit the two viruses should be continued. For long-range solutions to these problems, further investigations should be undertaken to find effective parasites and predators of sugar-crop pests and to develop varieties of sugarcane and sugarbeet that are resistant to insect attack. The usefulness of destruction of alternate host plants and new approaches to insect control, such as the male sterility technique and attractants, should be investigated. Research should aim to develop control methods without objectionable features. Key insect pests that require heavy use of insecticides for their control and thereby make the natural control of other pests on the same crops difficult are special problems that should receive emphasis in the search for nonchemical methods of control.

USDA AND COOPERATIVE PROGRAM

The Department has a continuing long-range program involving basic and applied research on the insect problems of sugarcane and sugarbeet directed toward developing efficient and economical control methods. This program is cooperative with State and Federal entomologists, agronomists, and chemists in the States where research is underway and with industry. Studies on sugarcane insects are conducted at Houma, La., and Canal Point, Fla.; and on sugarbeet insects at Mesa, Ariz., Twin Falls, Idaho, and Yakima, Wash. Research on factors affecting the efficiency of Trichogramma spp. as parasites of lepidopterous pests is being conducted under a research grant with the Louisiana State University.

The Federal scientific effort devoted to research in this area totals 8.8 scientists man-years. Of this number 1.0 is devoted to basic biology, physiology, and nutrition; 2.3 to insecticidal control; 0.7 to insecticide residue determinations; 1.2 to biological control; 0.6 to insect sterility, attractants, and other new approaches to control; 0.3 to evaluation of equipment for insect detection and control; 0.8 to varietal evaluation for insect resistance; 1.3 to insect vectors of diseases; and 0.6 to program leadership.

Federal support of research in this area under grant provides for 0.3 professional man-year devoted to biological control, and 0.3 to basic biology of the beet leafhopper.

Natural enemies of the sugarcane borer in India are being studied under a PL 480 project A7-ENT-1, by the Commonwealth Institute of Biological Control, Bangalore, India. Parasites and predators found effective for borer control will be made available for use in the United States. A second PL 480 project, A7-ENT-22 has recently been initiated in India on studies of Indian Jassidae with particular reference to Circulifer and related genera and their importance as vectors of plant virus diseases.

PROGRAM OF STATE EXPERIMENT STATIONS

A total of 5.0 professional man-years is devoted to this area of research.

PROGRESS -- USDA AND COOPERATIVE PROGRAM

A. Basic Biology, Physiology, and Nutrition

1. Sugarbeet Insects. At Twin Falls, Idaho, beet leafhoppers were more numerous than for the past several years. On May 18 there were 24 leafhoppers per 100 square feet in sugarbeet fields and by June 15 populations had increased to 212 per 100 square feet. Population samples in nearby desert breeding areas also showed high leafhopper populations, and various tests indicated that approximately 4% of the leafhoppers were carrying curly top virus, the highest percentage of virus carriers recorded since 1957 in this area.

Studies in Idaho showed that the sugarbeet root maggot overwinters in the larval stage, mostly along the beet row rather than between rows. The majority overwintered in the soil at a depth of 6 to 9 inches but many were found at a depth of 3 to 6 inches. This distribution remained constant even though the ground was frozen to a depth of 12 inches in February. By June 6, 1966, in an area near Paul, Idaho, 58% of the sugarbeet plants were infested with an average of 28 eggs per plant, resulting in an average of 5 maggots per plant. Although mortality between egg and early larval instars was high, damage was severe.

In laboratory studies, potted sugarbeet plants infested with 80 maggots per plant were killed. Those infested with 40 maggots per plant were severely damaged, but no noticeable effects were detected on plants infested with 5, 10, and 20 maggots per plant.

Field studies to develop suitable attractants for sugarbeet root maggot flies showed beet juice to be more attractive than sugar solutions, beet molasses, young beet plants, or beet roots.

At Yakima, Wash., 31 species of plants, representing 8 families, were found to be hosts of both the green peach aphid and the beet western yellows virus. Many of these are perennial or autumn-sprouted annuals which serve as overwintering sources of beet western yellows.

A new leaf miner, Psilopa leucostoma Meigen, of sugarbeets was discovered in Washington in 1962. Surveys made in 1965 showed the leaf miner present on sugarbeets in Washington, Oregon, Idaho, and northern Utah. Indications are that it may become a more serious pest than the spinach leaf miner, Pegomya hyoscami.

2. Sugarcane Insects. At Houma, La., first-generation population counts in the spring of 1965 showed an estimated average of 2,705 borer-killed plants per acre - 5 times the 1965 average of 549. This was due to a relatively mild winter which resulted in 58% borer survival. The annual harvesttime survey in Louisiana in the fall of 1965 showed an average bored joint (internode) infestation of 18% compared to 11% in 1964, 12% in 1963, and 6% in 1962, and an average of 16% for the 30-year period 1935-64. Estimated crop loss was 14% compared to 8, 9, and 5% for the crop years 1964, 1963, and 1962, respectively. The sugarcane borer infestation (joints bored) in Florida at time of harvest in 1965 averaged 4%. This is slightly less than in the previous year.

Plant cane in Florida was heavily attacked by lesser cornstalk borer. Armyworms and cutworms caused damage to some fields in both Florida and Louisiana. Although the European and southwestern corn borers are in northern Louisiana, they apparently have not reached the sugarcane area.

B. Insecticidal and Cultural Control

1. Sugarbeet Insects. In laboratory screening tests at Twin Falls, Idaho, against adults of the sugarbeet root maggot, beetplants were sprayed with insecticides and one day later infested with flies. Bomy1, Bay 39007, trichlorfon, diazinon, and naled gave 100% mortality in 4 hours. Bay 39007 and diazinon also produced 100% mortality of flies introduced 4 days after spraying.

Drill row treatments of granular carbophenothion, ethion, phorate, and Shell 9098 gave more effective control of the sugarbeet root maggot than topical band treatments, but in some instances were phytotoxic. None of the compounds performed as well as the heptachlor standard.

In tests at Yakima, Wash., foliar applications of granular formulations of 6 systemic insecticides satisfactorily controlled newly hatched larvae of the spinach leaf miner and an ephydrid leaf miner, P. leucostoma, before they mined the leaves of sugarbeets. All of these insecticides greatly reduced oviposition by the ephydrid leaf miner but only Temik® granules significantly reduced oviposition by the spinach leaf miner. In laboratory and field tests diazinon applied to the soil before sugarbeets were planted killed larvae of the spinach leaf miner as they mined the leaves and provided the first authentic record of systemic activity of this insecticide.

At Yakima, Wash., data supplied by cooperators showed that the sugar content of sugarbeets grown at Walla Walla, where beet yellows and beet western yellows is an annual problem, has increased since 1960 when most growers started applying systemic insecticides regularly for control of the green peach aphid, the principal carrier of the diseases.

A granular formulation of Temik® gave outstanding control of the green peach aphid on sugarbeets. Foliar applications were about as effective as pre-plant soil applications. Foliage of sugarbeet contained significant residues 146 days after treatment.

Sugarbeet wireworm larvae were less susceptible to aldrin soil treatments in Washington than during the 1949-51 period.

Post-planting sidedressings of granulated parathion, phorate, Stauffer N-290, and Bay 25141 applied at 3 pounds per acre reduced cullage resulting from wireworm injury 74.4 - 85.2%.

2. Sugarcane Insects. In large-scale aerial application tests in Louisiana, endrin and Guthion® were compared for sugarcane borer control at 5 different locations. Resistance to endrin was very evident at 2 locations where it gave only 15 and 7% control, respectively. At the other 3 locations there was no significant difference in the performance of the 2 insecticides, both giving about 90% control.

In a screening test on summer planted cane, Azodrin, endrin, ethion-endosulfan, and SD-8447 gave good control of the sugarcane borer with no significant difference between insecticides. Azodrin, which recently received a label for sugarcane borer control, gave better control when applied as a spray than as granules.

A comparison of automatic schedules of insecticide applications for sugarcane borer control with a schedule of applications made when weekly examinations show 5% or more of the stalks with larvae feeding behind the leaf sheath showed no significant difference between the 2 methods, even though the number of applications were the same.

C. Insecticide Residue Determinations

1. Sugarbeet Insects. Significant residues of aldrin and dieldrin were found in the raw sugarbeets, dried pulp, carbonation mud, raw juice, and first carbonation juice when preplant applications of the 2 insecticides were made at 5 and 3 pounds per acre, respectively, and mixed with the soil. Significant residue of dieldrin was also found in the cosettes. Analyses were made by the Pesticide Chemicals Research Branch at Yakima, Wash.

Aerial sprays of undiluted technical (LV) and conventional dilutions of malathion (10 gal/acre), each at 12 ounces actual per acre were applied to

sugarbeets. The initial malathion residues on sugarbeet leaves from the dilute and LV sprays were 5.98 and 13.25 ppm, respectively, and decreased after 14 days to 0.05 and 3.15 ppm.

Leaves of sugarbeets grown in 2 soils, each containing 2 ppm of diazinon and Stauffer N-2790, had 0.29 ppm of diazinon and 0.048 ppm of N-2790 at harvest.

When Temik® was applied in the furrow with sugarbeet seed at planting time at rates of 1, 3, and 6 pounds per acre, only the foliage from the 3- and 6-pound treatments contained detectable residues (0.03 and 0.06 ppm of Temik®).

D. Biological Control

1. Sugarbeet Insects. In preliminary field cage tests at Yakima, Wash., foliar sprays of a nuclear polyhedrosis virus gave 90% control of the zebra caterpillar on sugarbeets.

2. Sugarcane Insects. The annual 1965 fall survey made in the area where the Cuban fly, Lixophaga diatraeae, from Trinidad, B. W. I., was released for several consecutive years through 1959, indicated a parasitization of 26%. Parasitization percentages in recent years were as follows: 35 in 1964, 18 in 1963, 0 in 1962, and 13 in each of 1961 and 1960. Recovery examinations and observations made during the 1965 harvest season indicate that the Cuban fly is spreading. Breeding stock of the Louisiana strain of the Cuban fly is now being sent to Florida for use in breeding and release of this parasite in that State. Parasitism by Trichogramma minutum in summer plant fields of sugarcane in Louisiana during September averaged 38%.

In studies conducted at Louisiana State University under grant, on ecological factors affecting Trichogramma, it was determined that there are at least 3 and possibly 4 species of Trichogramma present in the natural populations in Louisiana. Humidity had little effect on development of the parasite, but temperature had a marked effect. For example, at 63-67° F the parasite developed from egg to adult in 29-31 days, at 90° F in 7-8 days. The parasites oviposited and developed normally in viable fertilized eggs, unfertilized eggs, and fertilized eggs that had been killed by exposure to 40° F for 30 days.

Studies were continued of predaceous arthropod fauna in fields with past histories of high and fields of low sugarcane borer infestations. In pit-fall traps operated during the last 2 growing seasons, 4 general groups of predaceous arthropods were collected, namely: ants, beetles, earwigs, and spiders. Ants, consisting of both native and imported fire ants may be mostly responsible for low borer infestations. The field with a history of low borer infestation yielded 106% more ants than the one with the highest borer infestation. There were also 90% more spiders in the lightly infested

field, indicating that these arthropods could be important in the borer-predator complex.

E. Insect Sterility, Attractants, and Other New Approaches to Control

1. Sugarbeet Insects. Deep drainage ditches in the Yakima Valley in Washington provided protection during the winter for summer forms of the green peach aphid and their weed hosts, many of which are also overwintering sources of the destructive beet western yellows virus. Truck-mounted propane burners were used to destroy the weeds along 42 miles of ditches within a 22-square mile test area in March of 1965 and 1966. In 1965 the aphid populations were greatly reduced on approximately 2,000 acres of sugarbeets within the control area and 74% fewer beets showed symptoms of the disease than in a similar area outside of the control area. Results through June 1966 showed 67% fewer aphids present on sugarbeets within the control area than in the outside area.

2. Sugarcane Borer. The artificial diet developed by Louisiana State University for rearing the sugarcane borer was improved by the addition of extra protein - Brewer's yeast, hydrolyzates of yeast, corn, casein, and soya. The diet containing soya hydrolyzate was the best diet, being equally acceptable to first as well as later instar larvae. Diets with Brewer's yeast were readily acceptable to later instar but not first instar larvae. Formaldehyde, Tegosept, and potassium sorbate were used to prevent bacterial contamination.

Preliminary data indicated that the total area of sensory surface of the male antennal flagellum was important for sensing the female pheromone. When antennae were removed, male moths had difficulties in making sexual contact with females.

Sex attractants of the cabbage looper, pink bollworm, and gypsy moth, supplied by the Pesticide Chemicals Research Branch, were tested on the sugarcane borer in the laboratory. There was no response.

Two 2-watt argon glow lamps, shown to be successful in attracting pink bollworm moths were field tested against the sugarcane borer in 1965. From May 18 to September 9 catches averaged less than 2 moths per trap per night although thousands of moths were in the field during the period.

F. Varietal Evaluation for Insect Resistance

1. Sugarcane Insects. Of 428 sugarcane varieties tested at Houma, La., in hand infested plots in 1965, 25% had a lower percentage of joints bored, and 37% produced more sugar per acre than standard variety C.P. 36-105.

Thirty-seven varieties of sugarcane consisting of one control variety, one new commercial variety, and 34 unreleased varieties were field tested under 2 levels of borer infestation in 1965 to obtain information on their relative tolerance. Varieties C.P. 58-48, L. 61-40, L. 6167, and C.P. 61-90

showed a loss of less than 7 pounds of sugar per acre for each 1% joints bored in both 1964 and 1965. The average loss for all 37 varieties in the test was 31 pounds in each of these two years. The greatest loss was shown by varieties L. 60-25, C.P. 61-41, L. 60-9, and C.P. 58-51. Their average loss for the 2 years ranges from 82 to 60 pounds for each unit of infestation.

Five new borer resistant parent varieties were recommended to sugarcane breeders in 1965 for use in their breeding program. The 5 varieties are: L. 61-40, L. 61-67, C.P. 61-90, C.P. 65-433, and H-58-7-150.

The borer infestation for 26 lines of corn and 3 of sorghum field tested at Houma in 1965 showed the sorghums to be generally more resistant than the corn. For the corn lines, infestations ranged from a high of 6.6 to a low of 2.0 borers per stalk. Lines MP 313E, L 501, SC 229MH, and 382(11)1-3 x 375(7)1-3 appear to be resistant when compared to the higher infestations in 409, 166, 304(11)1-2 X 471-U6, and 20 x 409. Of the 3 sorghum varieties tested Lindsey 77F had a lower infestation than either ODC 19 or Green M.

G. Insect Vectors of Diseases

1. Sugarbeet Insects. At Yakima, Wash., heavy applications of nitrogen fertilizer to sugarbeets resulted in masking symptoms of beet western yellows which is transmitted by the green peach aphid. In 1965 twice as many plants showed disease symptoms in untreated plots as in plots treated before planting time with 300 pounds of nitrogen per acre.

2. Sugarcane Insects. Tests were conducted at Houma, La., to determine if the spread of sugarcane mosaic could be reduced by controlling the insect vectors of the disease. In the first, toxaphene-DDT, General Chemical GC-6506, TDE, and diazinon applied with a spreader-sticker gave vector controls ranging from 67 to 100% with no disease reductions in any treatment. In the second, TDE and diazinon applied with and without spreader-sticker gave vector controls ranging from 38 to 100%. TDE with and without spreader-sticker reduced mosaic infection by 33% and diazinon alone showed a 13% reduction. All chemicals gave a 100% control of the rusty plum aphid, *Hysteroneura setariae*, one of 4 recorded vectors and the only species for which sugarcane is a natural host. No phytotoxicity was encountered with any of the insecticides.

Vector-virus relationship studies with the rusty plum aphid show that (a) the insect became viruliferous within 5 minutes after being placed on mosaic-infected plants; (b) viruliferous insects transmitted mosaic within 5 minutes after being placed on healthy sugarcane plants; (c) the aphid apparently lost the ability to transmit mosaic within 1 hour after being removed from diseased plants; (d) the rusty plum aphid was completely controlled by 6 insecticides in the field. However, controlling the vector had no apparent effect on mosaic spread.

Populations of 3 vectors of sugarcane mosaic virus, the corn leaf aphid, rusty plum aphid, and the ambrosia aphid, were lower than in 1964 in Louisiana.

PUBLICATIONS -- USDA AND COOPERATIVE PROGRAM

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Insecticidal and Cultural Control

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Insecticide Residue Determinations

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Insect Vectors of Diseases

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CROP HARVESTING AND HANDLING OPERATIONS AND EQUIPMENT
Agricultural Engineering Research Division, ARS

Problem. This area is concerned with the development of equipment and methods for efficiently harvesting and handling farm crops, with emphasis on the preservation of inherent qualities during these processes. The cost of harvesting and farm handling of most crops is the major expense of production, often amounting to over half of the total returns to the producer from the sale of the product. In addition, supply and adequacy of manpower for these operations are becoming progressively less satisfactory.

USDA AND COOPERATIVE PROGRAM

Equipment and methods for harvesting sugarcane are under study at Houma, Louisiana, in cooperation with the American Sugar Cane League; and in Belle Glade, Florida, in cooperation with the Florida Experiment Station.

A 3-year contract was initiated at Louisiana State University for research on mechanically removing tops and leaf trash from sugarcane.

The Federal engineering effort of 2.0 professional man-years is devoted to research on sugarcane.

PROGRESS -- USDA AND COOPERATIVE PROGRAMS

Sugarcane Harvesting Equipment

1. Stalk measurements for harvesting recumbent-type sugarcane. Several types of bottom cutters for cutting the cane stalk from the stubble have been studied with the aid of highspeed photography. Two of the machines studied were used in Louisiana and encountered difficulties when cutting recumbent cane from the loose muck soils in Florida. The cane stalks were noticeably moved when contacted by the rotating blades. This indicates that the cutting action is not fast enough for the large, tough canes in Florida. Once the cane stalk was pulled between the two knives on the machines with double bottom cutters, it was sheared quickly. Cane trash was not severed by the bottom cutters unless it was sheared against the stalk. Bottom cutting is critical due to a very shallow root system. Many individual stalks have only about 2 inches of effective root lying below ground or below the desired cutting point. The design of a cutting and pickup device using two horizontal augers with pickup fingers is underway and a demonstration unit has been built. This component will be located directly above one of the present types of bottom knives and will also cut the cane into short lengths and discharge it onto a conveyor.

Power requirements for harvesting recumbent sugarcane. No direct measurements were made although observations were made on most of the commercial and experimental harvesters operating in the area. The ground knife sometimes consumes the entire power of the engine and stalls the harvester when entering rows. It seems that an excessive amount of power is expended in operating the bottom knife beneath the surface of the ground either through a lack of control of the cutting height or because of uneven field conditions. Excessively large diameter knives are required to cover the spread of the sugarcane stools and misalignment of the stools in the row. An improvement in this could result in a smaller diameter knife and a reduction in power requirements.

Cutter knife control. Several experimental ideas have been explored by research and commercial personnel in the Everglades sugarcane area where soil conditions make knife control difficult, yet necessary. Attempts at visual control by placing an operator where he can either see the knife or the cut stubble have not been satisfactory. The use of skids, floating knives, balancing springs, etc., have shown some promise. An automatic system with a feeler shoe operating a hydraulic valve which actuates the cylinder to lift the knife when it drops too low has been quite successful at one of the mills. A similar two-way control has been set up in the laboratory.

Effect of trash on harvesting in early season. Experiments were made in August and September when cutting unburned cane for planting. One commercial sugarcane harvester would operate at a slow rate of speed, but faster speeds caused green trash to wrap around the pickup augers and cause chokage. This harvester chopped the cane into short lengths with a knife that also cut the trash cleanly. About 45 percent of the seed pieces were split by the knife, but after adding a shear plate, this was reduced to 10 to 20 percent. Modifications were made to the throat of the machine to aid in picking up cane grown on flat culture.

A commercial sugarcane cutter was used to windrow seed cane which was picked up, chopped, and loaded by a conventional continuous loader. The large amounts of trash on the plants caused some chokages with this machine; however, more trouble was encountered by the continuous loader with trash accumulating behind the saws than with the harvester. In reasonably straight cane, this cutter could harvest a one-fourth-mile row in 6 minutes. In the more recumbent canes, it could not be operated due to chokage around the bottom knife.

Cleaning cane for planting. The USDA Houma machine was operated for cutting seed cane to see what percentage of trash it would remove from Florida cane. In cane containing 32 percent trash, the machine topped and cleaned the cane down to 12.5 percent trash. Similar cane cut and topped by hand contained 13.9 percent trash. This cleaning principle is being tried by other producers for supplying cane to an experimental cane planter which will not work with trashy cane.

In operating this machine in Florida, the gathering chains had to be modified so that they could be lowered to pick up the recumbent stalks. Operation was best when these chains were allowed to run in the soil and no difficulties were encountered with this method. Cutting cane grown on flat culture caused a problem in disposing of the tops so that they would not be in the way when cutting the next row. Harvester efficiency was estimated to be between 80 and 85 percent.

Cleaning of cane on the conveyor. A cane orienting, cleaning and conveying device has been constructed in Florida for laboratory tests. It uses the notched-tooth cleaning principle in conjunction with a chain elevating conveyor. Combinations of notched-tooth cylinder speeds and chain speeds will be tried to determine the most effective orienting and cleaning speeds.

2. Mechanically removing tops and leaf trash from sugarcane. Experiments in Louisiana indicate that there is no significant difference in the density of the immature and the mature portions of the sugarcane stalk and that they cannot be separated by pneumatic means. There is, however, a significant difference in the density of the leaf material and the stalk so that these could be separated by any method utilizing the gravitational force of the materials. Pneumatic separation of the trash from mature cane is feasible only when the trash is detached from the stalk. Chopping stalks into short lengths is one method of detaching the trash. Tests to determine the deterioration rate for chopped cane under various storage conditions were not conclusive. Studies of removing trash by burning indicate that green leaf material would be difficult to remove by flame. Burning of dry trash is best when sufficient quantities of trash are available to sustain combustion. This work is being done under contract by the Louisiana State University Agricultural Engineering Department in cooperation with the Audubon Sugar Factory.

3. Mechanization of sugarcane production in Brazil. Two experiments are underway at the University of Sao Paulo, Brazil, under research contract using PL 480 funds. This work is concerned with minimum tillage in sugarcane and with the development of a mechanical harvester.

Results from two production seasons show that when two varieties were planted on unplowed pasture and compared with conventional seedbed preparation: (1) Germination was not affected; (2) tillering was better in plowed plots; (3) there was no difference in soil moisture; (4) weed population was the same; and (5) there was no significant difference in production yield of cane.

Early research on the development of a harvester was devoted to the construction of a tractor-mounted-stripper which utilized wire ropes or flails for removing leaves from standing cane. It was felt that the topping and cleaning should be performed as one operation followed by a separate machine for

the actual cutting and loading onto a wagon. Due to the short life of wire rope flails and resultant damage to the cane, additional research has led to the development of rayon-reinforced rubber flails which offer some solution to these problems. Utilizing this stripping system, a complete sugarcane harvester is now being designed that will cut the tops, clean the trash, cut off the cane and lay the stalks windrowed behind the unit to be picked up by ordinary loaders.

II. NUTRITION, CONSUMER AND INDUSTRIAL USE RESEARCH

SWEET SORGHUM UTILIZATION - FOOD Southern Utilization Research and Development Division, ARS

Problem. The Lower Rio Grande Valley, which is largely dependent on an agricultural economy, must have a greater selection of crops for diversification to meet unfavorable environmental and marketing conditions that frequently beset the area. Freezes in 1949 and 1951 and again in 1962 destroyed many citrus groves and generally retarded citrus production--a valuable source of farm income. Cotton, a mainstay crop, is also a surplus crop. In addition, yields in the Valley are frequently low, and insects and root rot pose troublesome problems. Many vegetables do well, but heavy losses have resulted from freezes, heavy rains, and maturation times that place the Valley vegetables in direct market competition with those grown in other parts of the U. S.

Sweet sorghum has potential for becoming a profitable diversification crop. There are now available new disease-resistant varieties with high sugar content. This factor, together with favorable world sugar prices, has encouraged consideration of sweet sorghum canes as a potential sugar crop for the Valley. The modest water requirements of sorghum and the sub-tropical climatic conditions conducive to an extended growing season increase its attractiveness. In addition, preliminary studies in processing encourage evaluation of this crop for the production of sugar; its process integration with those for beet and sugarcane would extend the use of costly raw sugar installations.

USDA AND COOPERATIVE PROGRAM

The Department has a continuing long-term program involving an organic chemist engaged at the U. S. Fruit and Vegetable Products Laboratory, Weslaco, Texas, in research to determine the chemical characteristics of juices obtained from selected new varieties of sweet sorghum canes grown in the Rio Grande Valley of Texas, and the effects of cultural and harvesting practices on the chemical characteristics in relation to suitability for sugar recovery; close cooperation is maintained with Substation 15, Texas Agricultural Experiment Station, Weslaco, Texas, for growing and harvesting breeding stock provided by the Crops Research Division.

The Federal scientific effort at the Southern Division devoted to research in this area totals 1.2 scientific man-years. All of this effort is on chemical composition and physical properties.

PROGRAM OF STATE EXPERIMENT STATIONS

A total of 2.5 scientific man-years is devoted to sweet sorghum and sugar crops utilization research.

PROGRESS -- USDA AND COOPERATIVE PROGRAMS

A. Chemical Composition and Physical Properties

1. Investigations of Chemical Characteristics of Sweet Sorghum to Evaluate Its Potential for Recovery of Sugar. Investigations of the chemical characteristics of new sweet sorghum canes to determine their suitability for sugar recovery have continued in cooperation with the Texas Agricultural Experiment Station at Weslaco and with the Crops Research Division. Such research on sweet sorghum canes in 1964 contributed to the selection and reevaluation of eleven nursery lines and varieties for 1965 planting tests. Analyses of the 1965 field test samples of sorghums from four areas are nearing completion. These data are essential in the evaluation of varieties and cultural practices. Simultaneously with these routine analyses, limited juice clarification studies were made, and means found to obtain flocculation and precipitation of more than 95% of the starch in the raw juice without use of heat. There have not yet been enough tests to establish the exact conditions under which optimum eliminations of starch, protein, bagacillo, and other objectionable impurities are attained, but a pH range of 7.5-8.5 appears to be important, as well as a juice Brix of 12-14% and the use of some polyelectrolyte such as Separan AP-30 at the level of 1-5 ppm. Evaluation of these extensive data should reasonably well establish the potential for growing in the Rio Grande Valley varieties with good prospects for commercial sugar production; however, progress has been limited in developing methods for purification of the juice for sugar recovery. (S5 5-51).

PUBLICATIONS -- USDA AND COOPERATIVE PROGRAMS

None.

RELATED PUBLICATIONS OF STATE EXPERIMENT STATIONS

Chemical Composition and Physical Properties

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Color, Texture and Other Quality Factors

- LeGrand, F. 1965. U. S. 59-16-1, a new sugarcane variety for south Florida. Fla. Agr. Exp. Sta. Circ. S-171, 12 p. (Florida)

Technology--Process and Product Development

- Samuels, G., Gonzalez-Tejara, E., and Alers-Alers, S. 1965. The handling of sugarcane trash in the humid areas of Puerto Rico. J. Agr. Univ. P. R., 49(1), pp. 76-87. (Puerto Rico)
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SUGAR BEET RESEARCH PUBLICATIONS

Utilization research on sugar beets at Western Utilization Research Laboratory was discontinued at the end of Fiscal Year 1965. The following publications pertain to the research prior to its termination:

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Avigad, Gad, Levin, Naomi, and Milner, Joram. 1964. Sucrose metabolism in plant storage tissues. Sixth Internal Congress of Biochemistry, New York City, July 26 to Aug. 1, 1964.1/

Markus, Z., Miller, G., and Avigad, G. 1965. Effect of culture conditions on the production of D-galactose oxidase by Dactylium dendroides. Appl. Microbiol. 13(5), pp. 686-693.1/

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1/ Research supported by P.L. 480 funds.

NUTRITION AND CONSUMER USE RESEARCH
Consumer and Food Economics Research Division, ARS
Human Nutrition Research Division, ARS

Problem. The assortment and characteristics of food available to consumers change constantly with the adoption of new practices of production, processing, and marketing. Changing constantly also, as nutrition science advances, is our understanding of the nutritional needs of man and the manner in which these needs can best be met by food. To help meet the Department's responsibility to advise consumers on the quantity and variety of foods that will assure maximum benefit and satisfaction, research must continue on the nutritional requirements of persons of all age groups, on the nutrient and other values of foods, and on ways to conserve or enhance these values in household and institutional preparation and processing.

The kinds and amounts of foods consumed by different population groups and individuals must be determined periodically by surveys so that the nutritional adequacy of diets can be evaluated. Information on food consumption and dietary levels provides the guidelines needed for effective nutrition programs. This information also furnishes the basis for market analyses for different commodities and for development and evaluation of agricultural policies that relate to production, distribution, and consumer use of food.

USDA AND COOPERATIVE PROGRAM

The Department has a continuing program of research concerned with (1) nutritive and other consumer values of raw and processed foods as measured by chemical or physical means and by biologic response; (2) effects of household practices upon the nutritive values and inherent qualities of foods, and the development of improved procedures for household food preparation, care and preservation; (3) nutritional appraisal of food supplies and diets of different population groups; and (4) development of guidance materials for nutrition programs.

The research is carried out by two divisions of the Agricultural Research Service -- the Human Nutrition and the Consumer and Food Economics Research Divisions. Most of the work is done at Beltsville and Hyattsville, Maryland; some is done under cooperative, contract, or grant arrangements with State Experiment Stations, universities, medical schools, research institutes, and industry. The total Federal scientific effort devoted to research in these areas is 72.6 man-years. It is estimated that 1.0 scientific man-year is concerned with studies related to sugar.

Human metabolic studies and the related exploratory and confirmatory studies with experimental animals and microorganisms concerned with defining human

requirements for nutrients and foods are not reported on a commodity basis, though some of the work is applicable to this report. This basic nutrition research represents a total Federal effort of 21.1 scientific man-years and is described in detail in the report of the Human Nutrition Research Division. Certain aspects of this research related to dietary carbohydrates are considered briefly in this report.

PROGRESS--USDA AND COOPERATIVE PROGRAMS

A. Nutritional Evaluation of Dietary Carbohydrate

Research in the Department and elsewhere has provided evidence that the kind of carbohydrate in the diet may influence metabolism under some conditions, and that the changes may be due to an interaction with other dietary ingredients. Research is continuing to find out more about the interactions of fats and proteins with different kinds and amounts of carbohydrates, their effects on body composition, and on the structure and functioning of tissues at various stages of the life cycle.

1. Kind of carbohydrate. Work on the nutritional value of wheat starch as compared to sucrose is continuing at Beltsville. Ten young women, 19-25 years old, ate a controlled diet in which 85 percent of the carbohydrate was provided by wheat starch or by sucrose for 30-day periods. The most dramatic response to source of carbohydrate was noted in the levels of lactate dehydrogenase (LDH) in the blood serum. Regardless of the sequence in which they ate the diets, 8 of the 10 women had elevated levels of this enzyme after eating the sugar diet for 30 days and depressed levels after eating the starch diet. LDH is an enzyme involved in the conversion of carbohydrates to energy or body fat. Two subjects were unresponsive, indicating the possible functioning of genetic factors. Less dramatic but yet significant was the difference between serum levels of alkaline phosphatase (higher on the sugar diet than on the starch diet). An elevation in serum alkaline phosphatase is associated with bone tissue formation. Two other serum components which showed significant differences between diets were creatinine (higher on the sugar diet) and total fatty acids (lower on the sugar diet). No significant differences due to dietary carbohydrate were found in nitrogen and magnesium retention, fat excretion and digestibility, or in serum levels of glucose, urea, total protein or protein components, glutamic-oxalacetic and glutamic-pyruvic transaminase enzymes, cholesterol, phospholipids, and glycerides. Portions of these results were reported at the meetings of the Federation of American Societies for Experimental Biology in Atlantic City and of the American Association of Cereal Chemists in New York in April 1966.

A similar dietary study with 10 young men (19-23 years old) has been initiated. A number of additional measures of biological response will be included.

Scientists in Israel, supported by a PL 480 Grant from U.S.D.A., have reported evidence that the kind of carbohydrate may have a marked influence on the level

of fat and cholesterol in the blood. Adult men and women of various ages, all prone to abnormally high levels of both triglycerides and cholesterol, were fed diets consisting of normal foods which supplied carbohydrates chiefly as sucrose or as starch. With the diets in which starch was the predominating carbohydrate, there was a precipitous drop in the blood triglycerides. Cholesterol levels followed a similar pattern but responded more slowly to dietary changes. Where sucrose predominated in the diet, a marked elevation of blood triglycerides and cholesterol occurred.

2. Influence of heredity. Research dealing with the response of two strains of rats, BHE and Wistar, has indicated that heredity may be a factor contributing significantly to the response to various carbohydrates. For these strains of rats, comparison of the responses to age and fasting suggest that the metabolic activity of the liver may be a factor contributing to the shortened life-span of the BHE rat fed sucrose.

The weight of the liver of the BHE rats fed sucrose increased with age, and was accompanied by a marked increase both in cholesterol and noncholesterol lipids. In contrast, the Wistar rats seemed to adapt with age to a high cholesterol diet. Liver weight remained unchanged and liver cholesterol decreased significantly. In spite of some relatively high liver lipids in 350-day-old BHE rats compared with those found in Wistar rats, survival of BHE rats fed cornstarch or glucose (though not those fed sucrose) was similar to that of Wistar rats fed comparable diets. Liver cholesterol was high in the nonfasted BHE rat fed cornstarch but, in contrast to the sucrose fed rat, decreased on fasting along with a significant decrease in liver weight. In the fasted BHE rats fed cornstarch or glucose, neither cholesterol nor noncholesterol lipid changed with age. Two papers are being prepared for publication, one dealing with the influence of dietary carbohydrate on the composition of the liver and on some serum lipids of BHE and Wistar rats and one dealing with the results of microscopic examination of the tissue of these rats.

A project to be carried out under a recently negotiated research contract with the Hazleton Laboratories at Falls Church, Virginia, also is directed toward increasing our knowledge of the influence of heredity on the response to dietary carbohydrate. In this study fructose, in addition to sucrose and cornstarch, will be the carbohydrates fed. The effects of changing the type of carbohydrate at 150 days of age also will be investigated. An extensive series of blood measurements will be made in an attempt to find measurements in blood that will predict metabolic differences on some diets due to inherited characteristics.

B. Tables of Food Composition

Summarization of data and derivation of representative values are nearing completion for a publication on the content of pantothenic acid, vitamin B₆ and vitamin B₁₂ in foods. The values will be given in terms of milligrams of the nutrient per 100 grams of edible portion and per 1 pound as purchased for each food item.

Also nearing completion is a preliminary table summarizing the data for 22 trace elements in foods arranged in 15 food groups. Data representing over 6,500 food samples analyzed for 1 to 22 trace elements have been reviewed, recorded on cards for punching and sorted by specific food. This table is particularly useful for indicating foods and food groups for which data are very limited or are conflicting.

A review of the vitamin E content of more than 5,000 food and feed items used for human and/or animal consumption was completed and published by the University of Wyoming at Laramie. This review was proposed and partially supported by the Human Nutrition Research Division. A total of 455 references were reviewed and fewer than 40 contained information on individual forms of tocopherols. The review was instigated by the increased recognition given to the importance of the tocopherols in metabolism of polyunsaturated fats and the extent of their use as naturally occurring antioxidants.

C. Food Consumption and Diet Appraisal

1. 1965 nationwide survey. Collection of data from the more than 15,000 households and 13,000 individual family members cooperating in the nationwide survey of food consumption in the United States is now complete. Tabulation of the data for households and preparation for tabulation of the data on individuals are in progress.

Preliminary review of the household data shows that family expenditures for food averaged \$33 a week in the spring of 1965. Of this, \$27 went for food bought and used at home, \$6 for meals and snacks eaten away from home. Home-produced and other foods for which no direct money outlay was made were valued at \$2. The money value of the food used averaged \$10.65 per person.

The total money value of food per family was 17 percent greater in the spring of 1965 than in 1955 when a similar survey was made. Most of the increase can be attributed to higher food prices but there was also a substantial increase in spending by farm families for food bought and eaten away from home. Their expenditures for eating out nearly doubled in the 10-year period and took 11 percent of total food money in 1965 compared to 7 percent in 1955. A report of the preliminary findings of the money value of food of households is being prepared.

Later, information will be available on the types and quantities of foods used by families in the spring of 1965. There will be information on approximately 250 foods--the percentages of families using the foods, average amounts, and the money value of the food used. Where pertinent, data will be shown separately for purchased, home-produced, and Federally donated food. Publications will be prepared on dietary levels provided by the foods used. Similar information will be published also for the 4 seasons. For individual family members, data will be reported for about 20 different sex-age groups, for the U.S. total and probably for 2 regions.

2. Diets and nutriture of preschool children. A study was initiated to determine the nutritional situation of children, 2 and 3 years of age, in low-income families in Hawaii. Children from low-income families will be compared with those from higher income families with similar ethnic backgrounds. Biochemical, clinical, and psychomotor tests will be used to assess nutritional state. Correlations will be sought with social and economic characteristics of the child's family. The study will be done under a Cooperative Agreement by the University of Hawaii.

3. Nutritive value of national food supply. Estimates of food energy (calories) and selected nutrients provided by the per capita food supply are calculated each year from data on apparent civilian consumption, retail basis, developed by the Economic Research Service. The estimates indicate that for the past 10 years, the level of food energy has remained around 3,150 calories per capita per day--about 10 percent lower than in 1909-1913. This lower calorie level is the net result of, about a 25 percent decrease in carbohydrate available for consumption, a 15 percent increase in available fat and a slight decrease in available protein, between 1909-1913 and 1965. This shift in the composition of the food supply caused the percentage of total calories furnished by carbohydrate to drop from 56 to 47 and the percentage of total calories furnished by fat to rise from 32 to 41. The percentage of total calories furnished by protein remained at about 12.

4. Nutritive content of school lunches. A nationwide study of the nutritive content of type A school lunches as served to sixth graders was initiated in cooperation with the School Lunch Division, Consumer and Marketing Service. Plans call for the collection and analysis of 20 lunch composites from 300 schools located in 19 states in five geographic regions. The objective is to provide data needed in evaluating the type A pattern. Because the pattern specifies the minimum amounts of foods required but does not specify maximum amounts that are allowed, the fat content of the lunches is of special concern.

5. Support for food and nutrition programs. Developments in nutrition research continue to be studied and interpreted for application to problems in food selection and food use.

In anticipation of the expansion of child feeding programs, a meal pattern for breakfasts and one for dinners suitable for children of all ages, were developed at the request of the School Lunch Division, Consumer and Marketing Service. These meal patterns will serve as guidelines for planning meals to meet the needs of children for food energy and the major nutrients. The patterns may be used independently or in conjunction with the type A lunch pattern.

To help promote better nutrition among low-income families, NCU food specialists and nutrition specialists cooperated with other Department agencies in the preparation of a teaching kit "Food for Thrifty Families." The kit consists of an adaptation of the "Daily Food Guide" and a series of 20 fliers that contain information on nutrition and simplified recipes for donated foods and foods relatively low in cost.

The bimonthly publication of Nutrition Program News was continued. This publication reaches about 7,000 workers in nutrition and related fields. Talks to groups involved in community nutrition programs, radio tapes, and consultant help and participation in conferences contributed to coordinating and strengthening of nutrition programs.

Preliminary plans were made for the fifth National Nutrition Education Conference which will be held in February 1967. The conference is cosponsored by CFE and the Interagency Committee on Nutrition Education. The theme will be coordination and communication in nutrition programs.

PUBLICATIONS -- USDA AND COOPERATIVE PROGRAMS

Nutritional Value of Carbohydrates

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Irwin, M. I., and Richardson, F. M. 1966. Effect of source of carbohydrate on levels of glucose, certain enzymes, and nitrogenous compounds in blood serum of young women. Cereal Sci. Today, 11, No. 4, 1954. (Abstract.)

Kaufmann, N. A., Poznanski, R., Blondheim, S. H., and Stein, Y. 1966. Changes in serum lipid levels of hyperlipemic patients following the feeding of starch, sucrose, and glucose. Amer. Jour. Clin. Nutr. 18, 261-269.

Klugh, C. A., and Irwin, M. I. 1966. Serum lipids of young women as related to source of dietary carbohydrate. Fed. Proc. 25, No. 2, 672. (Abstract.)

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Dicks, M. W. 1965. Vitamin E content of foods and feeds for human and animal consumption. Bulletin 435, Wyoming Agricultural Experiment Station, University of Wyoming, 194 pp.

Nutritive Value of National Food Supply

Friend, B. 1965. Nutritional review. Nat. Food Sit. NFS-114. Outlook issue. November.

Friend, B. 1966. Nutritive value of food available for consumption, United States, 1909-64. ARS 62-14. January.

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Consumer and Food Economics Research Division. 1965. Cost of food at home. Family Economics Review. October, pp. 20-21; December, p. 28.
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Peterkin, B. 1965. When you buy food. Chapter in Consumers All, 1965 Yearbook of Agriculture, pp. 416-419.

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Hill, M. M. 1965. Food to satisfy. Chapter in Consumers All, 1965 Yearbook of Agriculture, pp. 393-397.

Page, L. 1965. Calories and weight. Chapter in Consumers All, 1965 Yearbook of Agriculture, pp. 398-402.

1965. Family meals at low cost--using donated foods. Consumer and Marketing Service, Human Nutrition Research Division. Program Aid 472, 16 pp. (Rev.)

1965. Quantity recipes for type A school lunches. Consumer and Marketing Service; Agricultural Research Service; Fish and Wildlife Service, Department of the Interior. Program Aid 631. (Card File.) (Rev. of PA-271.)

1966. A menu planning guide for type A school lunches. Consumer and Marketing Service, Agricultural Research Service. Program Aid 719, 16 pp.

1966. Money-saving main dishes. Human Nutrition Research Division, Consumer and Food Economics Research Division. Home and Garden Bulletin No. 43, 45 pp. (Rev.)

PUBLICATIONS -- STATE EXPERIMENT STATIONS 1/Nutritional Value of Carbohydrates

- Carroll, G., and Bright, E. 1965. Influence of carbohydrate-to-fat ratio on metabolic changes induced in rats by feeding different carbohydrate-fat combinations. Arkansas. Jour. Nutr. 87, 202-210.
- Chang, Yet-Oy. 1965. Excretion of total nitrogen, lysine and methionine by rats as affected by the type of carbohydrate in the diet. Wyoming. Jour. Nutr. 85, 207-212.
- Reynolds, M. L., and Pringle, D. J. 1965. Metabolism of glucose and acetate in obese rats. Wisconsin. Jour. Nutr. 87, 357-362.

Consumer Quality and Use

- Baldi, V., Little, L., and Hester, E. E. 1965. Effect of the kind and proportion of flour components and of sucrose level on cake structure. New York City. Cereal Chem. 42, 462-475.

Food Consumption and Diet Appraisal

- Lamkin, G., Price, B. L., and Hielscher, M. L. 1965. Food purchasing practices of married students living in university housing. Illinois. Ill. Res. 7, No. 4.
- Stubbs, A. C. 1965. Food use and potential nutritional level of 1,225 Texas families. Texas. Tex. Agr. Expt. Sta. B-1033, 38 pp.

1/ This is a partial list for the calendar year 1965.

III. MARKETING AND ECONOMIC RESEARCH

ORGANIZATION AND PERFORMANCE OF MARKETS

Marketing Economics Division, ERS

Problem: Economic research in agricultural marketing revolves around the problems of increasing efficiency in the processing and distribution system and providing a foundation for orderly adjustments to changes inside and outside of agriculture. Marketing must be looked upon as a dynamic and changing process. The capacity to adjust to and cope with the dynamics of modern marketing is required increasingly of producers and distributors of farm products. Demands of a more knowledgeable and sophisticated consuming public are adding to the pressures for an even more rapid escalation of developments and changes within the marketing system. Changes in institutions and redirection of public policies and programs are modifying the economic environment in which marketing firms must perform and operate. Because of rapid changes and increasing complexities associated with a dynamic marketing system, it is necessary that a continuous program of research be conducted in marketing--a program aimed at keeping producers and marketing firms abreast of the flow of events and providing information necessary to them in making proper and orderly adjustments to change.

Research in the area of organization and performance of markets is designed to find solutions to economic problems of marketing, including the transportation of farm products. Such studies furnish a basis for adjusting to change and keeping abreast of technological and scientific developments. Likewise, the studies provide a sound basis for both private and public policy decisions as they relate to marketing.

USDA AND COOPERATIVE PROGRAMS

The Federal scientific effort pertaining to marketing of sugar involves 2.0 scientific man-years.

PROGRESS -- USDA AND COOPERATIVE PROGRAMS

A. Market Institutions and Market Power

Molasses and Noncaloric Sweeteners

A substantial part of the industrial molasses consumed in the United States is imported. The source of these imports has shifted greatly since 1960 when imports from Cuba ceased. The relative importance of various domestic sources of supply also has changed, following amendments to the Sugar Act in 1956 and later years.

Important shifts also have occurred in the relative importance of various uses made of industrial molasses. Use of industrial molasses for livestock feed has expanded greatly and now constitutes the largest market for the product.

The rapid increase in the consumption of noncaloric sweeteners--saccharin and cyclamate--since 1962 has created new competitive relationships in the sweetener industry, new opportunities and new problems, for both producers and users of sugar and other sweeteners.

The available evidence indicates that only about one-fourth to one-third of the noncaloric sweeteners consumed represented substitution for sugar; the remainder has served to enlarge the overall market for sweeteners. The percentage of noncaloric sweeteners used as replacement for sugar is likely to increase as the total usage of noncaloric sweeteners increases.

During the past year a survey has been made of producers and users of noncaloric sweeteners. The rapid growth in the consumption of soft drinks since 1950 shows no signs of slackening, and the likelihood prevails of some further increase in the share of noncaloric sweeteners in the soft drink market. A somewhat slower growth in the use of noncaloric sweeteners in other food industries appears probable.

B. Location and Interregional Competition

Sugar

Recent increases in the production of beet sugar, together with the growing importance of both corn and noncaloric sweeteners have intensified certain problems of importance to various groups of producers and users. The shipment of larger quantities of beet sugar for the long distances involved in finding a market have increased marketing costs and tended to lower the returns of processors and growers per pound of sugar or ton of beets marketed below what might otherwise have been obtained. The more rapid increase in the use of competing sweeteners than of sugar has reduced the growth of sugar consumption in the United States and created problems for sweetener users.

The increased proportion of beet sugar in total sugar consumption in the United States has resulted in a shift in the geographic pattern of refined sugar prices. Most of the beet sugar produced in the United States is manufactured in the western part of the country, and increasingly large quantities have been shipped to Chicago and eastern cities in recent years. This has been accompanied by price concessions and a general lowering of prices in the Chicago area relative to prices in New York. Since 1950, wholesale price quotations for sugar in Chicago have declined relative to New York quotations by .87 cent per pound.

COOPERATIVE MARKETING
Farmer Cooperative Service

Problem: Farmers continue to increase their use of cooperative marketing.

These cooperative operations are conducted in a marketplace where handling and processing, transportation, and distribution technology is changing rapidly, and market organization and practices are undergoing major changes. Farms themselves have changed. Farmers and their cooperatives need research results that relate to these developments and new conditions to assist them in marketing efficiently. Such research will assist farmers to strengthen their bargaining power, increase marketing efficiency, and meet effectively the quality, quantity, and service needs of today's food and fiber marketplace.

Cooperative marketing is a direct and major way for farmers to get maximum returns from their products. Farmers own and operate cooperatives specifically to increase their income from crops and livestock. Gains are not automatic, however. Cooperatives must plan and actually conduct the specific marketing program and services that will yield best returns for their members. Marketing cooperatives must know what the consumer demands, as reflected in the market. They must be able to estimate the cost of serving the market in different ways. They must understand the possibility of major economies in a well-managed joint sales program, and understand the methods and potentials of bargaining. Management must achieve minimum costs through appropriate organization, good use of existing plant and personnel, and the correct selection and use of new equipment and methods.

USDA AND COOPERATIVE PROGRAMS

Federal scientist man-years devoted to cooperative marketing on sugar amounted to 0.6 scientific man-years.

PROGRESS -- USDA AND COOPERATIVE PROGRAMS

A. Improving cooperative sales, distribution, and pricing methods

1. Bargaining. Research continues on bargaining methods and results in dairy, deciduous fruits and tree nuts, eggs, poultry, sugar beets and vegetables. This research seeks to appraise the status, role, and potentials of cooperative bargaining as a means of stabilizing and enhancing the incomes of producers.

B. Potentials in cooperative marketing

Sugar. Work was initiated on a study to appraise the status, organizational structure, operating experience, and potentials of sugarcane cooperatives.

